Community Intervention Trial for Smoking Cessation (COMMIT): I. Cohort Results from a Four-Year Community Intervention

*The COMMIT Research Group**

ABSTRACT

Objectives. The primary hypothesis of COMMIT (Community Intervention Trial for Smoking Cessation) was that a community-level, multichannel, 4-year intervention would increase quit rates among cigarette smokers, with heavy smokers (≥25 cigarettes per day) of priority.

Methods. One community within each of 11 matched community pairs (10 in the United States, 1 in Canada) was randomly assigned to intervention. Endpoint cohorts totaling 10 019 heavy smokers and 10 328 light-to-moderate smokers were followed by telephone.

Results. The mean heavy smoker quit rate (i.e., the fraction of cohort members who had achieved and maintained cessation at the end of the trial) was 0.180 for intervention communities versus 0.187 for comparison communities, a nonsignificant difference (one-sided $P = .68$ by permutation test; 90% test-based confidence interval (CI) for the difference = −0.031, 0.019). For light-to-moderate smokers, corresponding quit rates were 0.306 and 0.275; this difference was significant ($P = .004$; 90% CI = 0.014, 0.047). Smokers in intervention communities had greater perceived exposure to smoking control activities, which correlated with outcome only for light-to-moderate smokers.

Conclusions. The impact of this community-based intervention on light-to-moderate smokers, although modest, has public health importance. This intervention did not increase quit rates of heavy smokers; reaching them may require new clinical programs and policy changes. (*Am J Public Health.* 1995;85:183–192)

Introduction

As a primary objective in the goal to reduce cancer mortality rates in the United States, the National Cancer Institute (NCI) has specified a rapid reduction in the prevalence of smoking by adults. Although this prevalence steadily declined in the 1980s, more than 50 million Americans continued to smoke.[1] This fact showed the need for effective methods to help smokers quit. Since the early 1980s, the NCI has supported an extensive program of smoking cessation studies,[2] in which various interventions are separately developed and evaluated. These studies, which focus on specific agents of change (e.g., counseling by physicians, clinical interventions, work-site programs), have identified the most efficacious interventions among individuals and groups who volunteer to participate.

In 1986, the NCI funded the Community Intervention Trial for Smoking Cessation (COMMIT), a randomized controlled trial at the community level based on proactive efforts to reach smokers through existing social institutions.[3] The philosophy was to bring diverse organizations, institutions, and individuals together to conduct smoking cessation activities. It was assumed that a comprehensive communitywide strategy would make it difficult for residents to avoid exposure to messages about the importance of nonsmoking and would alert smokers to the many opportunities for cessation. Building on the results of previous studies,[2] COMMIT combined a variety of interventions intended to help smokers achieve and maintain cessation. The assumption was that the combination would be more effective than the sum of the individual component effects.

Community-based health promotion programs that include smoking cessation efforts have already been conducted, especially those focused on heart disease prevention[4–7] as well as other health goals.[8] In these earlier projects, however, efforts to change smoking behaviors were embedded in interventions designed to affect multiple risk factors simultaneously. Furthermore, only a few communities were used, and these were nonrandomly assigned to conditions, making it difficult to separate the effects of intervention activities from the inherent differences between communities.

In COMMIT, smoking was the only behavior targeted for intervention. Moreover, among community-based smoking-control studies, COMMIT was unique in that it randomly assigned communities to intervention, and it included a sufficient number of community pairs to provide good statistical power for detecting intervention effects on smoking cessation rates using the community as the unit of analysis.[9] The trial involved 11 matched pairs of communities: 10 in the United States and 1 in Canada (see Appendix B). Within each pair, one community was randomly assigned to intervention and the other served as comparison.

The design of COMMIT focused on the outcome for "heavy" cigarette smokers (those who smoked 25 or more cigarettes per day), whose smoking prevalence rates have been slower to decline

*See Appendix B for a complete listing of the members of the group.

Sylvan B. Green, MD, assumes full responsibility for the content and integrity of the paper.

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Editor's Note. See related editorials by Susser (p. 156) and Fisher (p. 159) in this issue.

than those of "light-to-moderate" smokers. Because heavy smokers represent one third of all cigarette smokers but account for nearly one half of all lung and other smoking-related cancers,[10] they are a group especially in need of targeting. Thus, reaching this population via a multichannel communitywide strategy was considered the most important aspect of COMMIT, although it was assumed that if this group could be reached, light-to-moderate smokers would also be affected.

Thus, the primary hypothesis tested in COMMIT was that a defined intervention, delivered through multiple community sectors and organizations over a 4-year period and using limited external resources, would result in higher quit rates among heavy cigarette smokers in the intervention communities than in the comparison communities. The outcome measure for testing this hypothesis was specified as the quit rate among a cohort of heavy smokers to be followed in each community; "quit rate" was defined as the fraction of cohort members who had achieved and maintained cessation for at least 6 months at the end of the trial. The expected quit rate for heavy smokers in the comparison communities was 0.15, and trial planners postulated a 0.25 quit rate in the intervention communities after the 4-year intervention. Because analysis of quit rates in light-to-moderate smokers was also planned, the outcome measures reported here are the quit rates in both smoker cohorts. Cross-sectional changes in prevalence were measured as another test of the intervention and are reported separately.[11]

Methods and Materials

Because the COMMIT intervention was community based, the community was chosen as the unit of randomization. The two communities within each of the 11 selected pairs were matched for geographic location (state or province), size, and general sociodemographic factors.[12] According to data from the 1990 Census (1991 in Canada), community populations varied from 49 421 to 251 208 residents, with comparable means for the pooled intervention and comparison communities. Further details on the communities and the matching are presented elsewhere (although this earlier report used 1980/1981 Census data).[12]

From January to May 1988, a telephone survey was conducted to estimate baseline prevalence and identify cohorts of heavy and light-to-moderate smokers within each community. Following that, the communities within each matched pair were randomized, one to the intervention and the other to the comparison condition.[9] Intervention started after randomization, beginning with mobilization of the communities. Specific intervention activities took place from January 1989 through December 1992, during which time cohort members were contacted annually by telephone. The final such contact occurred between January and May 1993, followed by the final prevalence survey from August 1993 to January 1994.

Trial Organization and Intervention

COMMIT was a partnership among 11 participating research institutions, the corresponding local communities, a coordinating center responsible for data management, NCI program staff, and NCI biostatisticians. A considerable amount of community mobilization was required to set the stage for protocol implementation.[13] Each community formed a community board that consisted of key community representatives, was charged with representing the COMMIT project to the community, and had overall responsibility for planning implementation of COMMIT interventions.

Intervention focused on four primary channels: public education through the media and communitywide events; health care providers; work-sites and other organizations; and cessation resources. Within these channels, the protocol specified 58 mandated activities, defined so they could be carried out largely by community volunteers or local staff or agencies with limited external resources. These activities were implemented through four community task forces (representing the four channels), each having a set of general goals and a set of measurable process objectives that guided the activities. Although COMMIT aimed at creating a demand for cessation services, funds were not provided to support such services directly. Appendix A summarizes the major mandated activities by task force; these are described in more detail elsewhere.[14-17]

A program records system, monitored by the coordinating center, was developed to check implementation of the protocol.[18] Process objectives for each protocol element established the minimum level of activity to be conducted annually in each community. For the four intervention channels, the mean level of attainment across the 11 sites varied from 90% to 93%. Nearly all mandated activities were implemented in a timely fashion.[19] Optional activities (such as training for pharmacists, mass media cessation campaigns, etc.) were also permitted by the protocol, and one or more optional activities were implemented in each intervention site. Because of the inherent variability of community needs and capabilities, COMMIT sought to strike a balance between standardization of activities across sites and the need for community tailoring.[19]

Each intervention community recruited a field director, who had primary responsibility for ensuring that the intervention protocol was implemented and who was accountable to both the community board and the research institution. The field director hired and supervised an office manager and, on average, two full-time intervention staff; all worked with the task forces to implement mandated activities. Including salaries, COMMIT provided each intervention community with an average of $220 000 per year for 4 years to support the intervention.

Identification of Endpoint and Evaluation Cohorts

The baseline survey was conducted centrally using a modified random-digit-dialing technique with community-specific geographic screening to identify households within the targeted areas.[11] The mean response rate (across communities) for the household-rostering portion of the survey was 83.7%, with approximately 5400 households contacted in each of the 22 communities; response rates have been recalculated since an earlier publication.[12] Of the smokers identified as such from the household rostering, 91.5% completed an extended interview. Based on this interview, a smoker was defined as someone who had smoked at least 100 cigarettes in his or her lifetime and who smoked currently at the time of interview; a heavy smoker was defined as one who reported smoking 25 or more cigarettes per day (either per weekday or per weekend day), while a light-to-moderate smoker reported smoking fewer than this number.

Approximately 550 heavy smokers and 550 light-to-moderate smokers between 25 and 64 years of age were identified in each community to be followed prospectively. An 80% sample was randomly drawn from each of these groups to form "endpoint cohorts," in whom smoking quit rates were to be determined for the principal COMMIT

outcome measures. The remaining 20% of the smoker groups served as "evaluation cohorts"[20] to assess three issues related to trial goals: (1) the impact of COMMIT on intervention program awareness, receptivity, and participation; (2) recognition of smoking as a public health problem; and (3) change in the social acceptability of smoking. Results from the evaluation cohorts will be presented in a later paper.

Endpoint cohort members were not explicitly notified of their status as cohort members. However, respondents were informed that they would be contacted annually. In 1993, at the final annual contact to assess smoking status, the endpoint cohorts were also asked a set of questions to assess intervention program awareness and participation. These questions were asked after smoking status was ascertained, so there was no possibility that asking such questions could affect estimates of quit rates. These questions also estimated awareness of and participation in tobacco control activities for comparison communities.

Steps were taken to contact cohort members even if they moved out of the community. To minimize attrition, various methods were used to obtain new telephone numbers for members who could not be reached at their last known number; these methods began with Directory Assistance, followed by telephone contact with any individuals whose names the cohort members may have provided, followed by searches by credit bureaus. The only information accessed in these inquiries was name, age, sex, address, and telephone number. At the final annual contact, cohort members who declined to be interviewed were asked if they would respond to an abbreviated set of questions about their current smoking status. Members not contacted by telephone were mailed these questions. These methods yielded data on current smoking status from an additional 6.7% of the combined endpoint cohorts.

To ensure that the cohorts remained as representative as possible of their communities, minimal telephone contact occurred during the trial and no intervention activities were directed specifically at individual cohort members. Trial investigators and local program staff were not informed of which smokers were selected for the COMMIT cohorts and were blinded to smoking status data during the trial. Population-based surveys were conducted centrally by independent contractors. All surveys were identified as being sponsored by the US Public Health Service or, in Canada, by the University of Waterloo and McMaster University, but none was linked to local COMMIT activities. Details have been presented elsewhere.[12]

Statistical Analysis

Separate analyses were performed using data from the 10 019 individuals in the heavy smoker endpoint cohort and the 10 328 members of the light-to-moderate smoker endpoint cohort, as defined at baseline. For the primary outcome measure of COMMIT, a "quitter" was defined as a cohort member who, at the final annual contact in 1993, reported not smoking any cigarettes for the preceding 6 months or longer. The quit rate (i.e., the fraction of cohort members who met this definition of quitting) was determined for each of the 22 communities, and the differences in quit rates between the intervention and comparison community of each pair were calculated.

Significance testing was done using a permutation test[21] accounting for the fact that communities (rather than individuals) were randomized and that this randomization was performed within community pairs. To perform the permutation test for a specific outcome variable, the mean of the 11 pairwise differences between intervention and comparison communities was calculated for each of the 2^{11} (= 2048) equally likely ways that the intervention assignments could have occurred during randomization. The rank of the observed mean among all 2048 possible means provided the significance level. As specified during the design phase of COMMIT,[9,12] one-sided permutation tests were used to analyze intervention effects. Permutation tests were also used to determine test-based confidence intervals (CIs) for the differences between intervention and comparison conditions; 90% confidence intervals are reported, corresponding to one-sided tests at the $P = .05$ level. Two-sided permutation tests were used to analyze comparability of follow-up (response rates) between intervention and comparison communities. When intervention effects were determined separately within subsets of cohort members defined by demographic factors, two-sided permutation tests were used to investigate the statistical interactions (i.e., the extent to which observed differences in intervention effects between subsets were consistent with chance).

Quit rates of intervention and comparison communities were compared in two ways. The first approach used the observed quit rates—namely, the fraction of those quitting among all individuals who provided information on their smoking status at the 1993 contact. This analysis omits those with missing data in 1993, which is equivalent, for point estimation, to inputing the quit rates of those individuals with known outcome to those with missing data. The assumption underlying such analysis is that the unknown outcomes are missing completely at random (MCAR).[22]

The second approach categorized individuals separately within each community into strata based on factors related to the final smoking outcome. Within each stratum, the quit rate of those not missing at final follow-up was used as the imputed probability of quitting for those with missing data. The quit rate for each community was then estimated by averaging over all cohort members in that community, with each known quitter assigned the value 1, each known continued smoker assigned the value 0, and each missing person assigned the quit probability that had been estimated for that individual's stratum. Such analysis is based on the assumption that the unknown outcomes are missing at random (MAR),[22] conditional on stratum membership. This assumption is less restrictive than missingness completely at random, so this procedure may be preferable to the MCAR analysis.

For this imputation, 16 strata were defined within each community; for each of these strata, data on those known in 1993 were used to impute quit rates for those missing in 1993. Initial stratification was done by reported smoking status on intermediate follow-up contacts in 1991 and 1992 (with each respondent classified as smoker, quitter, or missing), producing nine possible strata. Eight of these strata, representing individuals with one or more nonmissing observations in 1991 and 1992, were used without further subdivision. Those with missing information in both 1991 and 1992 were further classified according to 1990 status as smoker or quitter, thus producing two additional strata. For those with missing information in all three intermediate years and for those in a stratum with no individuals known in 1993, imputation was based on the two baseline variables selected as the most important variables in a stepdown logistic regression procedure[23] for the heavy smoker cohort using data from all 22 communities; these variables were time to the first cigarette of the morning (less

TABLE 1— Numbers (n) of Individuals in the Cohorts[a] and Fraction (*f*) of Those Who Met the Definition of Quitting, with Imputation for Those Unknown in 1993 (MAR Analysis)[b]

	Heavy Smoker Cohort (n = 10 019)					Light-to-Moderate Smoker Cohort (n = 10 328)				
	Intervention (n = 4976)		Comparison (n = 5043)			Intervention (n = 5177)		Comparison (n = 5151)		
Pair	n	*f*	n	*f*	Difference	n	*f*	n	*f*	Difference
1	442	0.139	435	0.205	−0.066	504	0.279	519	0.286	−0.007
2	531	0.163	489	0.202	−0.039	475	0.304	453	0.267	0.037
3	475	0.164	464	0.163	0.002	443	0.315	448	0.252	0.064
4	428	0.204	497	0.249	−0.045	463	0.345	475	0.299	0.046
5	440	0.183	458	0.160	0.022	473	0.342	472	0.332	0.010
6	450	0.164	454	0.186	−0.022	470	0.306	482	0.299	0.007
7	432	0.262	451	0.230	0.032	463	0.332	475	0.303	0.028
8	455	0.193	434	0.169	0.024	473	0.334	464	0.254	0.080
9	455	0.215	462	0.127	0.088	492	0.291	456	0.263	0.027
10	426	0.136	451	0.172	−0.036	479	0.244	467	0.256	−0.012
11	442	0.155	448	0.189	−0.034	442	0.273	440	0.218	0.055
Community means		0.180		0.187	−0.007*		0.306		0.275	0.030**

[a]In this table, n represents the sum of those with observed outcome and those with imputed outcome; estimates of quit rates based on such n have greater uncertainty than would occur with the same n if all had been observed.
[b]MAR = missing at random.
*P (one-sided) = .68; 90% confidence interval = −0.031, 0.019.
**P (one-sided) = .004; 90% confidence interval = 0.014, 0.047.

than 10 minutes, 10 to 30 minutes, more than 30 minutes) and age (25 to 39 years, 40 to 64 years). To attain more stable estimates for the six additional strata formed by a cross-classification of these variables, quit rates for each stratum were obtained using all individuals in that community with known information in 1993, including those with known intermediate smoking status.

In separate analyses, logistic regression was used to adjust for possible imbalances in individual-level covariates. Baseline covariates were chosen a priori because they were considered to be predictive for quitting cigarette smoking. The prognostic value of each covariate was first studied one at a time, with significance testing based on a logistic model with a single term for the covariate plus a separate intercept for each of the 22 communities. The covariates were then included together in a logistic model, along with a separate intercept for each community pair; stepdown regression was used to remove covariates not significantly prognostic (at the $P = .05$ level) when adjusted for other variables in the model. This stepwise procedure was done for the heavy smoker cohort; the selected variables were also used for the light-to-moderate smoker cohort although coefficients were obtained separately for each cohort. Because these models included no intervention indicator, they could be used to predict outcome under the null hypothesis of no intervention effect. By averaging predictions over individuals in each community, it was possible to determine residuals between observed and predicted quit rates. Differences in these residuals between the intervention and comparison communities of each pair were then calculated as a measure of intervention effect adjusted for baseline covariates, and a permutation test was performed on these paired differences.[9]

Using the data on perceived receipt of smoking control activities (awareness and participation), we calculated five "receipt indices," each associated with a major component of the COMMIT intervention, and three additional indices, which represent more general questions about tobacco control activities. An overall assessment was obtained by summing these eight separate indices. For this summary measure, each component index was "standardized" by subtracting its mean (based on individuals in the comparison communities) and dividing the remainder by its within-community standard deviation (obtained from analyses of variance). Standardization was done so that the separate component indices would have equivalent weights in the summary measure.

For analyses of number of cigarettes smoked, each individual was asked to provide estimates of daily consumption separately for weekdays and weekends, and these were combined into a daily mean. At baseline, the median daily cigarette consumption was 30 for heavy smokers and 15 for light-to-moderate smokers.

Results

As has been noted, COMMIT was a randomized trial with a sample size of 11 matched pairs of communities. In tables of results, these pairs are listed in arbitrary order and labeled 1 through 11; the individual communities are not identified. The order is the same across tables but does not correspond to the order in which the communities are listed in Appendix B.

Data Response Rates for Smoking Status Information

Data response rates (percentages of cohort members who provided smoking status at the final contact in 1993) were calculated separately by cohort. For the heavy smoker cohort, the means of the 11 community-level rates for the intervention communities, 67.9%, and the comparison communities, 67.8%, were virtually identical (two-sided $P = .88$ by permutation test). The corresponding rates for the light-to-moderate smoker cohort were 64.2% and 65.0%, also not significantly different ($P = .42$). There was much variability across communities but relatively little within pairs.

Most of the cohort members who were classified as nonresponders were those who could not be located, 28.6% of members (mean across communities); an additional 2.4% were reported deceased. For the remaining 2.8% (2.9% across intervention communities, 2.6% across comparison communities), the respondents refused to be reinterviewed or there was a problem obtaining the interview. Analysis of the heavy smoker cohort showed that attrition tended to be higher for younger, single, less educated respondents.

Cohort Quit Rates

Quit rates with imputation for missing values, using the MAR analysis described under Methods, are shown in Table 1. For the heavy smoker cohort, the

mean quit rate of the 11 intervention communities was 0.180, compared with 0.187 for the 11 comparison communities (one-sided $P = .68$ by permutation test). The 90% test-based confidence interval for the difference (−0.031, 0.019) includes zero. In contrast, the corresponding quit rates for the light-to-moderate smoker cohort were 0.306 and 0.275, and the difference of 0.03 (i.e., an additional 3% of light-to-moderate smokers quitting) was statistically significant ($P = .004$; 90% CI = 0.014, 0.047).

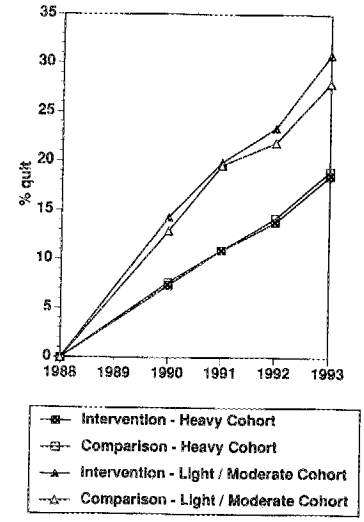
The observed quit rates (MCAR analysis) yielded quite similar results. For the heavy smoker cohort, the mean quit rate of the 11 intervention communities was 0.185 compared with 0.190 for the 11 comparison communities ($P = .63$; 90% CI = −0.030, 0.021). The corresponding quit rates for the light-to-moderate smoker cohort were 0.309 and 0.280, and this difference was statistically significant ($P = .004$; 90% CI = 0.015, 0.045).

A subsidiary MCAR analysis was performed with adjustment for individual-level baseline covariates. Ten covariates, chosen a priori, were first investigated individually for prognostic value within the heavy smoker cohort (Table 2). Stepwise regression selected five of these for use in adjusted analyses: age, time to first cigarette, desire to quit, marital status, and presence of another smoker in the household. Permutation tests on the residuals between observed and predicted quit rates, comparing intervention and comparison communities, gave results similar to the unadjusted analyses. For the heavy smoker cohort, there were 6717 individuals with known covariates and outcome; the adjusted analysis was not significant ($P = .66$). For the light-to-moderate smoker cohort, there were 6516 individuals with known data; the adjusted analysis was highly significant ($P = .003$). Thus, adjustment for possible imbalances in prognostic factors did not alter the conclusions derived from unadjusted analyses.

To gauge the public health impact on all smokers, the observed quit rates (MCAR) from both the heavy and light-to-moderate smoker cohorts were weighted in proportion to their prevalence at baseline in each community. The mean combined quit rate was 0.265 for intervention communities and 0.247 for comparison communities. The combined difference of 0.018 (i.e., an additional 1.8% of smokers quitting) was significant ($P = .031$; 90% CI = .002, 0.034).

TABLE 2—Observed Quit Rates in the Heavy Smoker Cohort, by Categories of Baseline Covariates

	n	Fraction Quitting	P (Two-Sided)
Age, y			
40–64	3649	0.206	<.0001
25–39	3138	0.165	
Sex			
Female	3033	0.176	.028
Male	3780	0.196	
Education			
No college	3014	0.192	.56
Some college	3787	0.183	
Age when started smoking, y			
<17	3170	0.180	.067
≥17	3640	0.193	
Cigarettes per day, no.			
≤30	4076	0.192	.17
>30	2709	0.179	
Time to first cigarette			
<10 min	3202	0.166	<.0001
10–30 min	2261	0.190	
>30 min	1335	0.234	
Desire to quit			
Not at all	1165	0.156	.0001
A little	1050	0.173	
Somewhat	2074	0.184	
A lot	2489	0.208	
Quit attempts in past year			
No or unknown	4358	0.179	.078
Yes	2455	0.201	
Marital status			
Married or live with partner	4714	0.197	.0007
Other	2077	0.165	
Another smoker in household			
No	4282	0.199	.0008
Yes	2531	0.166	



Note. Different numbers of subjects contribute at each time point. MCAR = missing completely at random.

FIGURE 1—Observed quit rates (MCAR) over time for heavy and light-to-moderate smoker cohorts.

The design of COMMIT specified that the primary outcome measure was the fraction of cohort members who had achieved and maintained cessation at the end of the trial. For descriptive purposes only, we plotted observed quit rates in 1990, 1991, 1992, and 1993 (Figure 1) to show trends in quitting over time. The data represent the fraction of respondents at each time point who reported not smoking cigarettes for at least 6 months at that survey time. Both smoker cohorts showed a steady increase in quit rates for intervention and comparison communities. Although the number of cohort members contributing to each point varies by year, thus requiring caution in interpretation, Figure 1 suggests an emerging difference in quit rates between intervention and comparison groups for the light-to-moderate smokers over time, with no intervention effect on quit rates for the heavy smokers.

The observed quit rates (MCAR) for the intervention and comparison communities by age, sex, and educational level are shown in Table 3 for both smoker cohorts; these demographic factors were selected a priori as being of interest. The nominal P values should be interpreted with caution because of the multiple comparisons involved. One interaction test was statistically significant, suggesting that the intervention effect did differ in the light-to-moderate smoker cohort according to educational level, with most of the beneficial effect of the intervention seen in the lesser educated subgroup. The other subgroup differences in intervention effect are consistent with chance.

TABLE 3—Numbers (n) of Individuals with Known Smoking Status and Community Mean Fraction (*f*) of These Who Met the Definition of Quitting, within Demographic Subsets

	Heavy Smoker Cohort						Light-to-Moderate Smoker Cohort					
	Intervention		Comparison				Intervention		Comparison			
Subset	n	*f*	n	*f*	Difference	*P**	n	*f*	n	*f*	Difference	*P**
Age 40–64 y	1813	0.205	1836	0.208	−0.003	.56	1682	0.318	1638	0.297	0.021	.26
Age 25–39 y	1569	0.162	1569	0.171	−0.009	.72	1618	0.303	1690	0.259	0.044	.03
Interaction						.78						.65
Female	1459	0.176	1574	0.176	0.000	.50	1880	0.306	1921	0.277	0.029	.011
Male	1934	0.192	1846	0.201	−0.009	.73	1437	0.314	1415	0.284	0.031	.049
Interaction						.56						.96
No college	1458	0.193	1556	0.191	0.002	.45	1332	0.302	1443	0.248	0.055	.007
Some college	1929	0.178	1858	0.192	−0.013	.80	1975	0.309	1889	0.306	0.004	.33
Interaction						.24						.032

*P values for the intervention effect within subsets are one-sided; interaction *P* values are two-sided.

TABLE 4—Differences in Receipt Indices, by Intervention Condition

	Heavy Smoker Cohort (n = 5950)				Light-to-Moderate Smoker Cohort (n = 5821)			
	Community Means				Community Means			
Index (Allowable Minimum–Maximum Values)	Intervention (n = 2972)	Comparison (n = 2978)	Difference	*P**	Intervention (n = 2890)	Comparison (n = 2931)	Difference	*P**
Cessation resources (0–6)	0.691	0.650	0.041	.11	0.600	0.569	0.031	.11
Health care (0–6)	1.861	1.735	0.126	.023	1.353	1.299	0.054	.062
Work-sites (0–7)	2.179	2.137	0.042	.28	2.390	2.322	0.068	.20
Media/public education (0–16)	7.833	7.658	0.175	.14	7.621	7.542	0.079	.29
Religious organizations (0–10)	2.682	2.762	−0.080	.70	2.976	2.912	0.065	.28
Programs and materials (0–10)	5.507	5.041	0.466	.011	5.465	5.056	0.409	.007
Events and contests (0–10)	3.754	2.970	0.784	.001	3.783	3.067	0.716	.001
Smoking unacceptability (0–10)	6.254	6.261	−0.006	.52	6.176	6.019	0.157	.18
Summary (standardized)	0.695	0.118	0.577	.012	0.386	−0.178	0.563	.004

Note. The first five receipt indices are associated with a major component of the COMMIT intervention; the last three represent general questions about tobacco control activities.
*P values are one-sided.

Number of Cigarettes Smoked

The daily number of cigarettes that an individual smoked was analyzed as an additional measure of behavioral change. Differences between baseline and final contact were calculated, with quitters having a value of zero at the final contact, and the median difference was determined for each community. For the heavy smoker cohort, the decrease in number of cigarettes smoked in the 11 intervention communities (community mean) was 9.2, compared with 8.9 in the comparison communities; the difference of 0.3 cigarettes per day was not significant ($P = .13$). For the light-to-moderate smoker cohort, the corresponding values were 2.7 and 1.9; the difference of 0.8 reached statistical significance at $P = .03$. These results are consistent with the quit rate analysis.

Intervention Receipt Indices

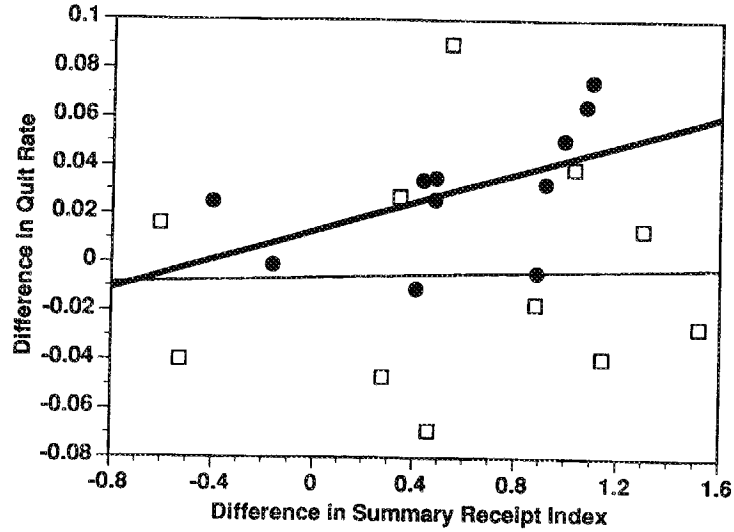
In the heavy smoker cohort, data on intervention receipt indices were available (on average) for 59.4% of members in intervention communities and for 59.1% of members in comparison communities, amounting to a nonsignificant difference in data response rates ($P = .79$); similarly, for the light-to-moderate smoker cohort, these rates were 55.9% and 57.1%, respectively ($P = .20$). The observed data were used without imputation. Results are shown in Table 4; larger values of an index correspond to greater awareness and/or participation. All but two indices in the heavy smoker cohort and all indices in the light-to-moderate smoker cohort showed a difference in favor of the intervention communities although some of these differences were not statistically significant by permutation test. Importantly, the summary measure was significantly greater for the intervention communities in both cohorts ($P = .012$ among heavy smokers and .004 among light-to-moderate smokers).

Even when statistically significant, the magnitudes of the differences in receipt indices were not large. The largest (and most significant) difference in both cohorts was for the index based on the respondents' evaluation of the increase in stop-smoking events and contests in their

community. More details of receipt indices are planned for a future paper. (A list of survey questions contributing to specific receipt indices is available from the authors.)

Relation of Differences in Quit Rates and Receipt Indices

As one way of exploring the variability in quit rate differences across community pairs, we computed a receipt index difference for each community pair (using the standardized summary measure), which we then correlated with the MCAR quit rate difference in each community pair. As seen in Figure 2, the variability across community pairs in receipt index difference did not result in a correlation with differences in quit rates among the heavy smokers (rank order correlation = 0.13; $P = .71$), but there was a significant correlation among the light-to-moderate smokers (rank order correlation = 0.75; $P = .01$). This suggests that in the light-to-moderate smoker cohort, where the COMMIT intervention did produce a behavioral change, the magnitude of this intervention effect was related to the magnitude of the difference in awareness of (or participation in) smoking control activities.



	Correlation	Rank Correlation
Heavy Cohort	0.04 (p=0.90)	0.13 (p=0.71)
Light / Moderate Cohort	0.54 (p=0.09)	0.75 (p=0.01)

Note. MCAR = missing completely at random.

FIGURE 2—Relation of the differences in observed (MCAR) quit rate (between communities in a pair) and the differences in summary intervention receipt index for heavy and light-to-moderate smoker cohorts.

Discussion

The COMMIT intervention did not significantly affect the primary outcome measure—quit rates among heavy smokers—where quitting was defined as having smoked no cigarettes for at least the preceding 6 months at the end of the trial. For the heavy smoker cohort, the mean quit rates for the intervention and comparison communities were nearly identical: 0.180 versus 0.187 (MAR analysis with imputation for missing values). Quitting in the comparison communities was somewhat greater than the expected rate of 0.15, but the anticipated intervention effect of increasing the quit rate to 0.25 clearly was not achieved.

There was, however, a statistically significant intervention effect in the light-to-moderate smoker cohort—quit rates of 0.306 versus 0.275—with the mean difference showing an additional 3% of such smokers quitting. The success of the COMMIT intervention in affecting smoking behavior among light-to-moderate smokers is an important public health finding. As an illustration, when the 3% mean difference in light-to-moderate cessation rates is extrapolated to the community level, it is reasonable to conclude that more than 3000 smokers (in the target age interval of 25 to 64 years) in the 11 intervention communities were induced to quit beyond the naturally occurring secular trend. The higher quit rates for light-to-moderate smokers compared with heavy smokers are consistent with findings from the community trial in California[24] as well as with other smoking cessation studies.[25]

The analyses here showed little difference between men and women in the effect of the COMMIT intervention; there was no benefit for heavy smokers of either sex but there was an additional 3% quitting among light-to-moderate smokers of both sexes. Among light-to-moderate smokers, the less educated subgroup appeared more responsive to the intervention than the college-educated smokers. Given the report that more cessation activity has been occurring nationwide among smokers at higher education levels,[26] it is possible that the type of intervention provided by COMMIT adds little to secular trends among this group, whereas less educated smokers might benefit more from community-based antismoking messages.

The intervention receipt indices provide objective comparisons of the perceived level of activity in intervention and comparison communities. Differences in these indices were mostly in the expected direction, and differences in the summary index were statistically significant for both smoker cohorts. The magnitudes of these differences, however, were modest and may account for the lack of intervention effect for heavy smokers and for the modest intervention effect for light-to-moderate smokers.

The results show a moderately strong rank correlation between pairwise receipt index differences and pairwise quit rate differences for the light-to-moderate smoker cohort. Both heavy and light-to-moderate smokers in the intervention communities had greater perceived exposure to smoking control activities than their counterparts in comparison communities. However, for the heavy smokers, unlike for the light-to-moderate smokers, this exposure was not reflected in higher quit rates. This might be because the receipt of the COMMIT intervention was not large enough to affect heavy smokers, because 4 years was not long enough for a

community intervention to take hold and affect heavy smokers, or because a different type of intervention is necessary.

COMMIT also tried to ascertain intervention delivery and receipt by several special population surveys administered in both intervention and comparison communities. These data are still under analysis and will provide additional information that may help in interpreting the results reported here.

The COMMIT design had a number of important strengths. Intervention was assigned by randomization. Communities were both the unit of assignment and the unit of analysis; the matched pair design,[9] the number of pairs, and the successful matching within pairs[27] yielded sufficient statistical power to detect a relatively modest (but important) 3% difference in light-to-moderate smoking cessation rates. Moreover, the 90% confidence interval on the intervention difference in quit rates among heavy smokers indicates that an actual intervention benefit exceeding two percentage points for heavy smokers is unlikely.

We consider the best estimates of cohort quit rates to be those based on stratum-specific imputation for missing values at final follow-up (MAR analysis). However, using the observed quit rates (MCAR) gave almost the same results. Individuals in the cohorts were not direct participants in a trial but were simply respondents to telephone surveys, and thus missing data were due predominantly to failure to locate people with limited tracking information. Therefore, naive estimation assuming that all unlocated individuals were still smokers would provide such poor estimates of true quit rates as to be of no value, so this was not done.

Self-reports were used to determine trial endpoints; this is because a single biochemical measurement cannot validate sustained quitting (i.e., for 6 months or longer), it may be influenced by other nicotine sources, and it can only be collected from that subset of telephone survey participants willing to volunteer a sample. COMMIT did, however, undertake an ancillary study with salivary cotinine measurements (after all self-reports from cohort members were completed) to estimate the extent of false reporting of quitting and especially to estimate possible differential rates of such misrepresentation. Preliminary analysis of these data showed that misrepresentation rates in quitters from the heavy smoker cohort who participated in the ancillary study were 5.1% in intervention communities versus 7.7% in comparison communities; for the light-to-moderate smoker cohort, the corresponding rates were 6.8% versus 8.8%. These differences were not statistically significant and were in the direction of reduced (rather than greater) false reporting in the intervention communities. Further analyses of this ancillary study will be reported in a later paper. Other researchers also have discussed this topic.[28,29]

There were two notable limitations of the COMMIT intervention that may have affected outcomes. First, the standardized protocol may have constrained some communities from undertaking activities that might have had greater impact. In general, however, community boards seemed quite satisfied with the protocol.[30] Second, the protocol did not permit emphasis on some kinds of policy or environmental changes that might have been quite powerful, such as working toward tax increases on cigarettes.

That the COMMIT intervention did not change quit rates of adult heavy smokers is disappointing but consistent with the findings of most other community studies on smoking cessation.[7,24,31,32] Achieving and maintaining cessation among heavy smokers is difficult. Thus far, only intensive clinical programs and pharmacological interventions have demonstrated a significant effect on the quit rates of heavy smokers,[1,33] and even they have had only a modest impact on cessation rates.

Based on sound principles of experimental design, COMMIT allowed a rigorous evaluation of its community-based intervention. As expected from secular trends, quitting did occur in comparison and intervention communities among heavy as well as light-to-moderate smokers. The intervention had a modest beneficial influence on this trend for light-to-moderate smokers, and thus it did produce an effect on smoking cessation with public health implications. Light-to-moderate smokers were responsive to broad-based community approaches to smoking control, and such efforts should continue. However, addicted heavy smokers are more resistant to change. Reaching these smokers may require new clinical programs and public policy changes.

Comparisons of the cohort results reported here with outcomes from the cross-sectional surveys are presented separately, along with additional discussion of the implications of COMMIT findings.[11] Continuing analyses of data from COMMIT should provide further insights for future community-based health promotion programs. □

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APPENDIX A—Key Mandated Activities for COMMIT Task Forces

Public Education
- Provide media advocacy training for community board members
- Implement kick-off event
- Publicize smoking control plans
- Design and implement magnet events[a]
- Publicize activities in other task force areas

Health Care Providers
- Train physicians and dentists as trainers of peers in cessation techniques
- Provide basic and comprehensive training for physicians/dental professionals in smoking-cessation techniques for their patients
- Provide office consultation for motivating and training office staff to support cessation activities
- Promote smokers' network (mailing list)
- Promote smoke-free policies in health care facilities

Work-Sites
- Offer presentations and on-site consultations to promote smoke-free policies in worksites
- Hold annual smoking policy workshops
- Offer promotional activities accompanying magnet events[a]
- Promote work-site stop-smoking incentives
- Disperse self-help materials
- Promote smokers' network (mailing list)

Cessation Resources
- Develop and maintain a cessation resources guide
- Recruit heavy smokers into a smokers' network (mailing list) through magnet events[a] and other activities
- Prepare and distribute a semiannual newsletter to smokers' network members

[a]For example, Quit & Win contests, the Great American Smokeout, and Canada's Non-Dependence Day.

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Continued

APPENDIX B—A Complete List of Institutions and Individuals Constituting the COMMIT Research Group

Members of the writing group for "Community Intervention Trial for Smoking Cessation (COMMIT): I. Cohort Results from a Four-Year Community Intervention" are indicated by one asterisk; those who wrote "Community Intervention Trial for Smoking Cessation (COMMIT): II. Changes in Adult Cigarette Smoking Prevalence" are indicated by two asterisks. (I) = intervention community; (C) = comparison community.

National Cancer Institute

- *Division of Cancer Prevention and Control; Cancer Control Sciences Program (Bethesda, Md).* Acting Associate Director: Thomas J. Glynn, PhD; Coordinator, Smoking and Tobacco Control Program: Donald R. Shopland.
- *Division of Cancer Prevention and Control; Public Health Applications Research Branch (Bethesda, Md).* Chief: Marc Manley, MD, MPH; COMMIT Program Director: William R. Lynn, BS.*,**
- *Division of Cancer Prevention and Control; Biometry Branch (Bethesda, Md).* Acting Chief: Laurence S. Freedman, MA*,**; Lead Research Investigator: Sylvan B. Green, MD*,**; Computer Systems Analyst: Donald K. Corle, MS*,**; Mathematical Statisticians: Barry Graubard, PhD, Stuart Baker, PhD.
- *Division of Cancer Prevention and Control; Prevention and Control Extramural Research Branch (Bethesda, Md).* Acting Chief: Sherry L. Mills, MD, MPH; Public Health Advisor: Daria A. Chapelsky, MPH.
- *Division of Cancer Etiology; Biostatistics Branch (Bethesda, Md.)* Head, Epidemiologic Methods Section: Mitchell Gail, MD, PhD*,**; Medical Statistician: Steven Mark, MD, ScD.

Chair, Steering Committee

Erwin Bettinghaus, MA, PhD, Michigan State University.

Research Institutions

- *American Health Foundation (New York, NY).* Community pairs: Yonkers (I), New Rochelle (C). Principal Investigator: Mario A. Orlandi, PhD, MPH; Co-Principal Investigator: Alfred McAlister, PhD; Co-Investigators: Jacqueline Royce, PhD; Eugene Lewit, PhD; Project Director: Lesa T. Dalton, BA; Field Director: Avril Dawkins, BA; Community Analyst: Bonnie Edelman, BS.
- *Fred Hutchinson Cancer Research Center (Seattle, Wash).* Bellingham (I), Longview/Kelso (C). Principal Investigator: Beti Thompson, PhD; Co-Investigators: Maureen Henderson, MD, DrPH; Deborah Bowen, PhD; Community Analyst: K. Mark Leek, MA; Field Director: Juliet Thompson, BA.
- *Kaiser Permanente Medical Care Program, Northern California Region, Division of Research (Oakland, Calif).* Vallejo (I), Hayward (C). Principal Investigator: Lawrence Wallack, DrPH; Co-Investigator: Kitty Corbett, PhD; Project Director: Robert McGranaghan, MPH; Field Director: Sandy Tosti; Field Director (until 1/90): Joan Bennett, MA.
- *Lovelace Institutes (Albuquerque, NM).* Santa Fe (I), Las Cruces (C). Principal Investigator: Neill F. Piland, DrPH; Project Director: Lawrence R. Berger, MD, MPH; Community Analyst: Annette M. Phillipp, MPH; Field Director: Aile Shebar, RN.
- *Oregon Research Institute (Eugene, Ore).* Medford/Ashland (I), Albany/Corvallis (C). Principal Investigator: Edward Lichtenstein, PhD*,**; Co-Principal Investigator: Russell E. Glasgow, PhD; Project Coordinator: Linda Nettekoven, MA; Field Director: Carolyn Johnson, BS; Community Analyst: Shari Reyna, MA.
- *Research Triangle Institute (Research Triangle Park, NC).* Raleigh (I), Greensboro (C). Principal Investigator: Tyler D. Hartwell, PhD**; Co-Principal Investigator: Robert H. Shipley, PhD; Project Director: David Austin, MS, MPH; Project Director (until 9/89); Elizabeth T. Walker, BS; Field Director: Len Stanley, MPH; Community Analyst: Bonnie Veaner, MPH; Community Organizer: Carol Stephenson, BS.
- *Roswell Park Cancer Institute (Buffalo, NY).* Utica (I), Binghamton/Johnson City (C). Principal Investigator: K. Michael Cummings, PhD, MPH*,**; Co-Principal Investigator: Terry F. Pechacek, PhD; Project Director: Russell C. Sciandra, MA; Community Analyst: Eva Anderson Sciandra, BS; Field Directors: Janine Sadlik, BS, Sharon Ann Rankins-Burd.
- *University of Iowa (Iowa City, Iowa).* Cedar Rapids (I), Davenport (C). Principal Investigator: Paul R. Pomrehn, MD, MS; Project Director: John E. Ferguson, PhD; Co-Investigators: Kristi J. Ferguson, PhD; Robert B. Wallace, MD, MS; Samuel L. Becker, PhD; Harry A. Lando, PhD (University of Minnesota); Community Analyst: Virginia Daughety, PhD; Community Analyst (until 2/92): Kelly O'Berry, BS; Field Director: Aleena Erickson, BA.
- *University of Massachusetts Medical School (Worcester, Mass.)* Fitchburg/Leominster (I), Lowell (C). Principal Investigator: Judith K. Ockene, PhD*,**; Co-Principal Investigator: Glorian Sorensen, PhD; Project Coordinator: Linda C. Churchill, BS; Field Director: Barbara Silva; Community Organizers: Philip Merriam, MSPH; Gary Donnelly, MPH; Community Analyst: Edward Purcell, BS; Community Analyst (until 7/89): Kristine Sanden, BS.
- *University of Medicine and Dentistry of New Jersey (Newark, NJ).* Paterson (I), Trenton (C). Principal Investigator: Norman Hymowitz, PhD**; Co-Principal Investigators: Lawrence Meinert, MD; Lee B. Reichman, MD; Norman L. Lasser, MD, PhD; John Slade, MD, Project Director: Karel Campbell, BA; Co-Project Director: Janice Marshall, RN, MSN; Field Director: Sharon Jones Rudolph, BS; Community Analyst: Connie Strickland Farrakhan, MA.
- *University of Waterloo (Waterloo, Ontario) and McMaster University (Hamilton, Ontario).* Brantford (I), Peterborough (C). Principal Investigator: J. Allan Best, PhD; Co-Investigators: Roy Cameron, PhD; Charles H. Goldsmith, PhD; Elizabeth A. Lindsay, MS, PhD; Blake D. Poland, PhD; Nancy A. Ross, MA; Edward Smith, DrPH (until 6/89); S. Martin Taylor, PhD; Leslie Van Dover, PhD, RN; Norman F. White, MD; Douglas M.C. Wilson, MD; Mark P. Zanna, PhD; Project Director: Rosemary L. Walker, MSc; Community Analyst: Terri Finch, BA; Field Director: Dianne Ferster.

Coordinating Center

- *Information Management Services, Inc (Silver Spring, Md).* Principal Investigator: Janis A. Beach, AA; Co-Principal Investigator: Carol A. Giffen, DVM*,**; Project Director: Marie A. Topor, BS; Senior Information Specialists: Jerome L. Felix, MA; Lauren E. Rich, BS; Systems Analysts: James J. Rovan, BS; Rusty Shields, BS; Survey Statistician: Charles D. Palit, PhD; Biostatistician: David Pee, MPhil; Project Coordinator: Mary L. Lamb, BA.

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Chair: Virginia L. Ernster, PhD; Karl Bauman, PhD; David M. Burns, MD; Richard Carleton, MD; William T. Friedewald, MD; Kenneth E. Warner, PhD; Donald Iverson, PhD, also served as Chair (1987–1988); Charles Hennekens, MD, DrPH.